BioMAP Report SWR-3
Ministry of Environment and Energy
Southwestern Region
Water Resources Assessment Unit
985 Adelaide St. South
London, Ontario N6E-1V3

ENVIRONMENTAL ASSESSMENT OF MILL CREEK IN THE VICINITY OF THE PORT ELGIN LANDFILL SITE, BRUCE COUNTY

by

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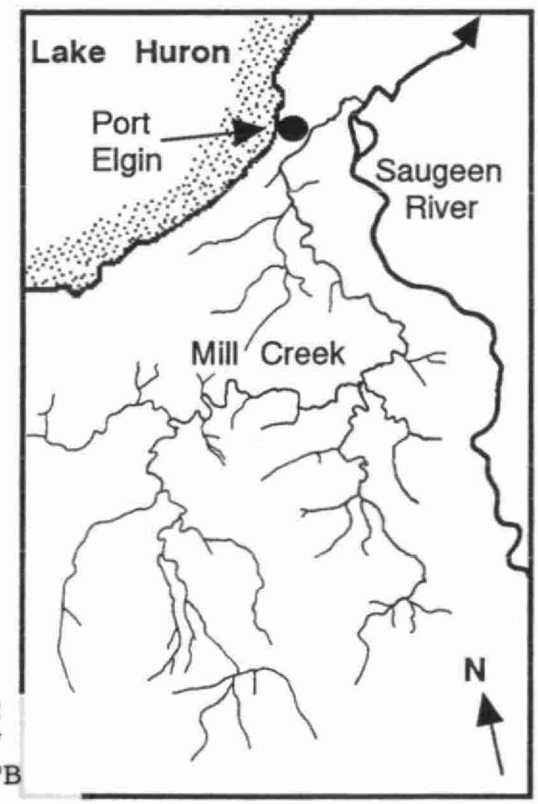

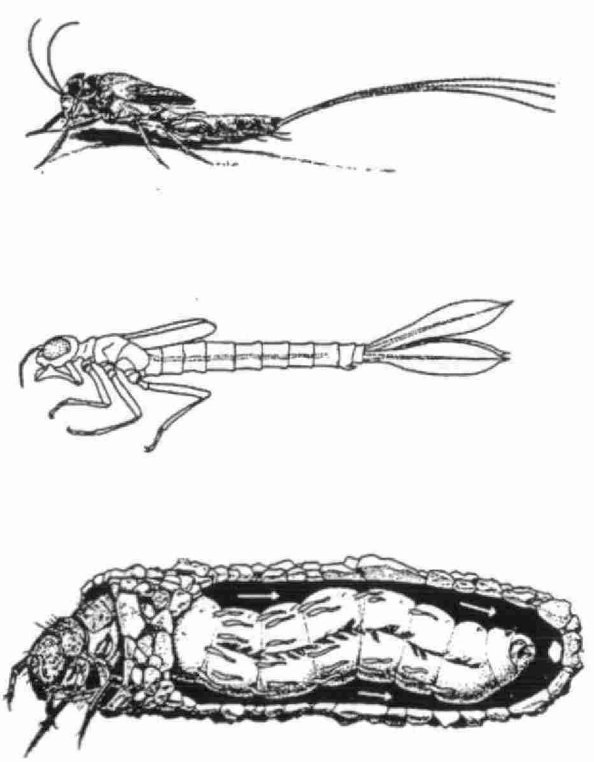

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EXECUTIVE SUMMARY

The Southwestern Region of the Ministry of Environment and Energy conducted an environmental assessment in August of 1993 to document the ecosystem health of Mill Creek in the vicinity of the Port Elgin Landfill Site and determine if leachate from the landfill was affecting water quality. Toxic conditions were not evident in the stretch of Mill Creek receiving leachate. The noticeable growth of filamentous green algae, however, suggests that the leachate may have a localized nutrient enrichment effect on the stream ecosystem. The benthic macroinvertebrate fauna found throughout the study area was indicative of an nutrient-enriched, warm-water stream. The wide occurrence of agriculture in the drainage basin and storm-water drainage from the Port Elgin area likely account for the impaired health of the creek.

INTRODUCTION

The Port Elgin Landfill Site is located to the east of Port Elgin, Ontario, adjacent to the sewage treatment plant and consists of a closed (old) landfill site and an active (new) landfill site (Figure 1). Dames and Moore, Canada Limited (1993) noted that a plume of leachate containing chlorides, ammonia and iron was migrating from the Port Elgin Landfill Site towards Mill Creek, which flows along the eastern boundary of the landfill site. Because the leachate could enter the creek through groundwater inputs and disrupt the aquatic community, a concern was raised regarding the water quality risk from the advancing leachate plume from both the old and new landfill sites. Ammonia concentrations of up to 13 mg/L were noted from observation wells near the creek in the late 1980's (Morrison Beatty 1991); ammonia is a major concern because it suggests anaerobic conditions within the groundwater and is lethally toxic to aquatic life at low concentrations (Hellawell 1986). In response, the Southwestern Region of the Ministry of Environment and Energy conducted an environmental assessment to document the ecosystem health of Mill Creek in the vicinity of the landfill site and determine if leachate from the landfill was affecting water quality.

MATERIALS AND METHODS

To assess the water quality of Mill Creek in the vicinity of the Port Elgin landfill site, three sampling sites were established along the creek (Figure 1). Site 1 was located upstream of the landfill site and was assumed to represent reference water quality conditions. Site 2 was located in a stretch of the stream where the leachate plume from the old landfill site was suspected to enter Mill Creek. Site 3 was located downstream of the plumes from the landfill sites and possible overflows from the sewage treatment plant. Treated sewage from the sewage treatment plant is not discharged to Mill Creek, but is piped under the creek and discharged to the Saugeen River. No further sites were located downstream of Site 3 because of obvious impacts on the stream caused by cattle with unlimited access.

Samples of benthic macroinvertebrates and water were collected between August 16 and 18, 1993. Standard BioMAP sampling procedures were used to sample the benthic fauna (Griffiths 1993); two quantitative samples, collected with a Surber sampler enclosing a 0.09 m^2 area, and a single 30-minute qualitative sample (bucket and sieve) were taken at each site. The

Surber sampler had a 600-μ mesh collecting net. The benthos were sorted alive from the debris and preserved in 80% ethanol. The processed samples were transported to the Southwestern Regional office in London for identification.

Water samples were collected at each site on August 18 and analyzed at the Southwestern Regional Laboratory in London for: ammonia, total Kjeldahl nitrogen, nitrite, nitrate, total phosphorus, dissolved reactive phosphorus, pH, conductivity, and chloride.

Observations of stream characteristics, plant and algae growth, fish and wildlife were noted throughout the study area. Stream characteristics were also recorded using photography and video. Water temperature and conductivity were measured in the field. A Magellan 5000 GPS unit was unit to determine the UTM co-ordinates of the sampling sites.

RESULTS

Mill Creek near the landfill site was characterized by even-flow sections dispersed with riffle areas. The stream width varied between 2.6 and 9.5 m. Water depths ranged from 5 cm in riffles to 2 m in pools. The bottom of the stream was composed of small boulders, cobble, gravel and sand. The stream banks exhibited erosional damage; many gravel and sand bars were present in the floodplain indicating that the stream periodically experienced high flows. These conditions were most evident at sites 2 and 3. The riparian habitat was generally forested, except for a small stretch of meadow between sites 1 and 2.

The water was clear with a temperature of 23° C at all sites. Phosphorus concentrations were similar among sites, whereas conductivity, nitrate and chloride concentrations increased from Site 1 to Site 3 (Table 1). In contrast, ammonia concentrations declined from Site 1 to Site 3.

At Site 1, located upstream of the County Road #17 bridge (Figures 1 & 2), the substrate was composed of small boulders, cobble, gravel and sand (Figure 3). Sparse moss and diatom growth covered the cobble. Marl (travertine) was deposited over the larger cobble, likely associated with the growth of mosses and algae (e.g. diatoms). At Site 2, the substrate was composed of cobble, gravel and sand (Figure 2). The filamentous green alga, *Cladophora*, covered approximately 60% of the riffle area, but the fronds (filament length) were only a few centimetres long. A beaver was completing a dam approximately 150 m upstream. At Site 3, the

substrate was composed of small cobble, gravel and sand (Figure 2). Pronounced iron staining (orange colour) was noted over portions of the substrate. Riffle areas were about 60% covered with *Cladophora* stubble. *Spyrogyra* was common in even-flow areas, beginning downstream of Site 2 and continuing downstream of Site 3 (Figure 3).

Macroinvertebrate densities were similar among sites, ranging from 700 to 1200 per 0.09 m^2 (Figure 4). Species richness was also similar among sites; the number of taxa per 0.09 m^2 (alpha richness) ranged from 30 to 37 (Figure 4) while the number of taxa per site (gamma richness) ranged from 48 to 54. A total of 80 taxa was collected throughout the study area (Table 2). Insects accounted for 98% of the benthic fauna at sites 1 and 2 and 94% of the fauna at Site 3. Worms were not found at Site 1, but accounted for 1% and 4.5% of the fauna at sites 2 and 3, respectively. Filter-feeding macroinvertebrates (e.g. *Cheumatopsyche*, *Hydropsyche*, *Microtendipes*, tanytarsinid midges, clams) increased from 55% of the fauna at Site 1 to 72% of the fauna at sites 2 and 3, whereas scrapers (e.g. *Helicopsyche*, heptageniid mayflies, psephenid beetles, snails) declined from 29% of the fauna at Site 1 to 15% of the fauna at Site 3. A shift in species composition was also noted: baetid mayflies, *Stenonema pulchellum*, *Stenonema mediopunctatum*, and lumbriculid worms increased in density from Site 1 to Site 3, while *Petrophila*, *Stenelmis crenata*, *Psephenus herricki*, flatworms, and the dipterans: *Microtendipes*, empidids, tipulids, athericids, declined in density from Site 1 to Site 3 (Table 2).

Fish were present throughout the study area; rock bass (*Ambloplites rupestris*), white sucker (*Castostomus commersoni*), common shiner (*Notropis cornutus*), creek chub (*Semotilus atromaculatus*), darters (*Etheostoma*) and a northern brook lamprey (*Ichthyomyzon fossor*) specifically were observed. The green frog (*Rana clamitans*) and the northern leopard frog (*Rana pipiens*) were noted throughout the floodplain. Frogs were also observed in the pond located between the old landfill site and Mill Creek. The water in the pond had a conductivity of 630 µS and temperature of 24° C.

DISCUSSION

The higher chloride concentrations at sites 2 and 3 (approximately 14 mg/L) relative to Site 1 (8 mg/L) implies that leachate from the Port Elgin landfill site is gaining access to Mill Creek via groundwater inflow. Toxic conditions, however, were not evident in this stretch of Mill Creek. Macroinvertebrate density and species richness at sites 2 and 3 were not less than that found at the

reference site (Site 1). In addition, the abundance of species sensitive to metal concentrations, such as baetid and heptagenid mayflies (Clements 1994; Clements et al. 1992), actually increased from Site 1 to Site 3. The observed occurrence of frogs and fishes throughout the study area similarly suggests that the leachate entering the creek was not having toxic effects on the aquatic biota.

The benthic macroinvertebrate fauna found throughout the study area is indicative of an nutrient-enriched, warm-water stream. The density of macroinvertebrates in similar sized, unimpaired (healthy) streams in Grey and Bruce Counties typically range from 100 to 500 organisms per 0.09 m^2 (Westwood 1982, 1983; Griffiths, unpubl. data). The macroinvertebrate density in the study area of Mill Creek was 50% to 150% higher than the maximum density noted in unimpaired streams. The wide occurrence of agriculture in the drainage basin and storm-water drainage from the Port Elgin area likely account for the impaired health of the creek.

The noticeable growth of filamentous green algae downstream of Site 2, however, suggests that the leachate may have a localized nutrient enrichment effect on the stream ecosystem. Ammonia concentrations ranging up to 13 mg/L have been measured in water samples from observation wells near the creek during the late 1980's (Morrison Beatty 1991). The average ammonia concentration in the groundwater near the creek was estimated to be 0.2 mg/L in 1993 (Dames and Moore, Canada Limited1994), about an order of magnitude greater than that measured in the creek (Table 1). Similar growth of filamentous green algae has been observed in the Bighead River adjacent to the Meaford landfill site (Griffiths, personal observation), in the Rocky Saugeen River adjacent to a landfill site near Markdale (Westwood, personal observation), and in the Middle Thames River downstream of a rendering facility that infiltrated ammonia-enriched wastewaters adjacent to the river (Griffiths, personal observation).

The occurrence of filamentous algae at sites 2 and 3 probably accounts for many of the differences observed in the community structure of the benthic fauna relative to Site 1. Filamentous algae is a food resource to some macroinvertebrates, provides food resources in the form of periphyton, growing on the stands of the filamentous algae, and organic matter filtered from the stream for others, provides attachment surfaces for filter-feeders, increases habitat heterogeneity by slowing currents, trapping detritus, blocking light, altering dissolved oxygen concentrations and daily pattern, and excludes some taxa by occupying attachment sites (Dudley et al. 1986). The higher abundance of baetid and heptagenid mayflies and lumbriculid worms at sites 2 and 3 probably reflects the increased availability of periphyton and organic matter provided by

the filamentous algae and the protection afforded by the algae from strong currents. The reduced proportion of scrapers noted at sites 2 and 3, particularly *Stenelmis*, *Psephenus herricki*, *Helicopsyche* and *Petrophila*, probably reflects the reduced availability of open space habitat used by these taxa because of the growth of the algae. The higher proportion of filter-feeding macroinvertebrates at sites 2 and 3, such as the caddisflies: *Hydropsyche*, *Chimarra*, *Psychomyia*, and the midges: tanytarsini, *Microtendipes*, probably reflects the increased availability of stable attachment points for their nets provided by the algal mats. The greater proportion of filter-feeders at sites 2 and 3 is probably a result of the greater availability of seston (food) in the stream produced in the more lentic waters observed through the "meadow section" of the stream and behind the beaver dam; the closer proximity of Site 2 to this source of food likely accounts for the higher density of filter-feeders relative to Site 3. The lower abundance of flatworms at sites 2 and 3 possibly reflects the reduced area of open space habitat and increased siltation which fouls their mucus-trail traps, reducing their ability to catch prey.

In conclusion, the leachate currently entering Mill Creek from the Port Elgin Landfill Site is not toxic to aquatic life. The occurrence of filamentous green algae, however, suggests that the leachate is likely having a localized nutrient-enrichment effect on the stream ecosystem. Differences in the benthic macroinvertebrate fauna relative to an upstream reference site appear largely to be a result of the filamentous algae modifying habitat conditions.

ACKNOWLEDGEMENTS

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Table 1: Water chemical characteristics at 3 sites along Mill Creek. Water samples were collected on August 18, 1993. See Figure 1 for locations of sites.

Chemical Variables Location (UTM)	SITE 1 4 919 677 N 469 820 E	SITE 2 4 920 344 N 470 674 E	SITE 3 4 920 520 N 470 830 E
Ammonia-N (mg/L)	0.041	0.030	0.026
Total Kjeldahl Nitrogen (mg/L)	0.56	0.44	0.47
Nitrite-N (mg/L)	0.01	0.02	0.02
Nitrate-N (mg/L)	0.9	1.1	1.5
Total Phosphorus (mg/L)	0.016	0.017	0.012
Dissolved Reactive Phosphorus (mg/L)	<0.001	<0.001	<0.001
pH	7.98	7.88	7.93
Conductivity (μS)	521	559	561
Chloride (mg/L)	8.0	14.1	13.7

Table 2: Mean density of benthic macroinvertebrates (number per 0.09 sq. m) at 3 sites along Mill Creek collected from August 16-18, 1993. P denotes that the taxon was present at the site. See Figure 1 for location of sites.

	Sites 1	2	3
Insects:			
ALDERFLIES:			
Sialidae:			
Sialis			0.5
AQUATIC MOTHS:			
Lepidoptera			
Pyralidae:			
Petrophila	62	13.5	6
BEETLES:			
Dytiscidae:			
Deronectes		0.5	
Hydroporus			P
Elmidae:			
Dubiraphia bivittata	P	P	
Dubiraphia vittata	6.5	6	8.5
Macronychus glabratus	0.5	0.5	P
Microcylloepus pusillus			0.5
Optioservis	7	22.5	24
Optioservis fastiditus	1.5	3.5	
Optioservis trivittatus	0.5	12.5	2
Stenelmis	138.5	23	11.5
Stenelmis crenata	6	2.5	1.5
Haliplidae:			
Peltodytes		0.5	P
Hydrophilidae:			
Berosus			P
Helophorus			1
Psephenidae:			
Ectopria	0.5		0.5
Psephenus herricki	47	0.5	
BUGS:			
Corixidae:			
Sigara			P
Gerridae:			
Limnoporus			P
CADDISFLIES:			
Helicopsychidae:			
Helicopsyche	32	119.5	6
Hydropsychidae:			
Cheumatopsyche	288	329	338
Hydropsyche	71.5	385.5	60
Hydroptilidae:			
Hydroptila	1	2	1
Leptoceridae:			
Oecetis	1.5	2	
Limnephilidae:			
Hydatophylax		P	
Neophylax	1		
Pycnopsyche	P		P

Table 2: continued.

	Sites 1	2	3
Philopotamidae:			
Chimarra	62	102	54
Polycentropodidae:			
Neureclipsis		1	
Polycentropus		P	
Psychomyiidae:			
Psychomyia		5	1
DAMSELFLIES:			
Calopterygidae:			
Calopteryx maculata		P	
Coenagrionidae	P		0.5
DRAGONFLIES:			
Aeshnidae:			
Basiaeschna		P	
Boyeria			P
MAYFLIES:			
Baetidae:			
Acentrella ampla		2	6.5
Acerpenna pygmaeus	11	6.5	13.5
Baetis sp.C	P	9.5	20.5
Baetis spp.	2	2.5	18
Centroptilum (ss)		P	P
Caenidae:			
Caenis	0.5	6.5	0.5
Ephermerellidae:			
Seratella		4.5	
Ephemeridae:			
Ephemera simulans			P
Heptageniidae:			
Stenacron interpunctatum	1.5	P	0.5
Stenonema femoratum		P	P
Stenonema mediopunctatum	P	0.5	15
Stenonema pulchellum	P		2.5
Stenonema sp.A			0.5
Stenonema	1	1.5	6.5
Oligoneuriidae:			
Isonychia		4.5	1.5
Tricorythidae:			
Tricorythodes			0.5
TRUE FLIES:			
Athericidae:			
Atherix	1.5	0.5	
Chironomidae:			
Chironomini	26.5	38	21
Chironomini Genus A	1		
Cryptochironomus	1	1	
Microtendipes	44.5	35.5	4.5
Tanytarsini	15	34	16
Orthocladiinae	4.5	7	13
Pentaneurini	20.5	20.5	9
Monodiamesa		0.5	

Table 2: continued.

	Sites		
	1	2	3
Empididae:			
Hemerodromia	4	2.5	0.5
Simuliidae			0.5
Tipulidae:			
Antocha	1	0.5	
Hexatoma		1	
Tipula	2	0.5	
Crustaceans:			
AMPHIPODS:			
Gammaridae:			
Gammarus	0.5		1
Talitridae:			
Hyalella azteca	0.5		2
CRAYFISHES:			
Astacidae:			
Orconectes propinquus	P	P	P
ISOPODS:			
Asellidae:			
Caecidotea			0.5
Molluscans:			
CLAMS:			
Sphaeriidae:			
Sphaerium	6.5	1	0.5
SNAILS:			
Ancylidae:			
Ferrissia	0.5	1	5
Hydrobiidae:			
Amnicola	P		P
Physidae:			
Physella	1	1	P
Planorbidae:			
Gyraulus	P		
Helisoma anceps	P		
Valvatidae:			
Valvata tricarinata	P		P
Annelids:			
WORMS:			
Lumbriculidae		18	32
LEECHES:			
Glossiphonidae:			
Placobdella parasitica	P		
Phylum Platyhelminthes:			
FLATWORMS:			
Tricladida	9.5	2.5	
Organisms per Sample	883	1236	708
Taxa per Sample	30.5	36.5	33.5
Taxa per Site	48	51	54

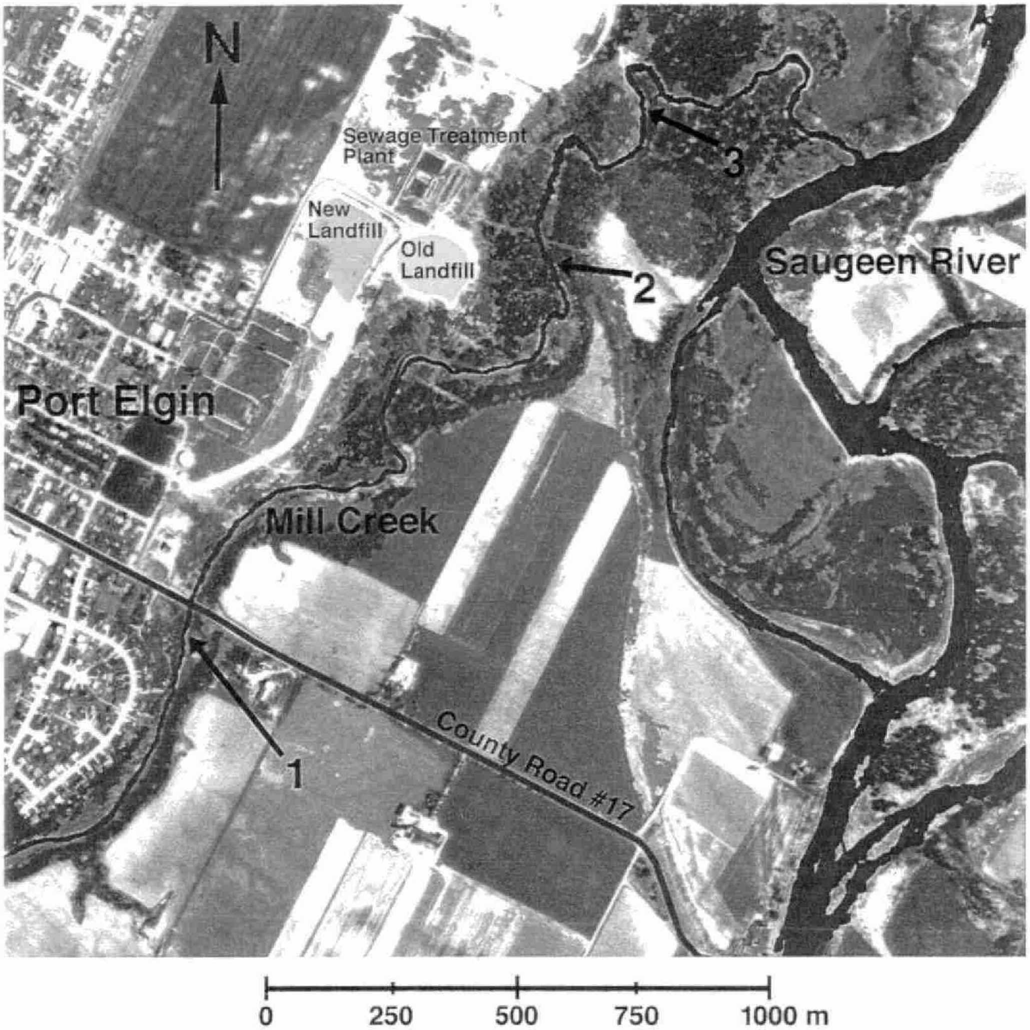

Figure 1: Location of the biological sampling sites along Mill Creek, August 1993.

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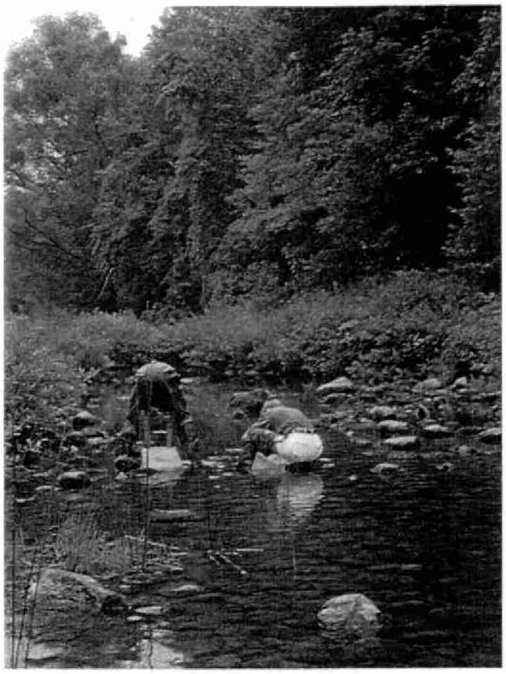

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Figure 2: Pictures of sampling sites 1, 2, and 3 along Mill Creek.

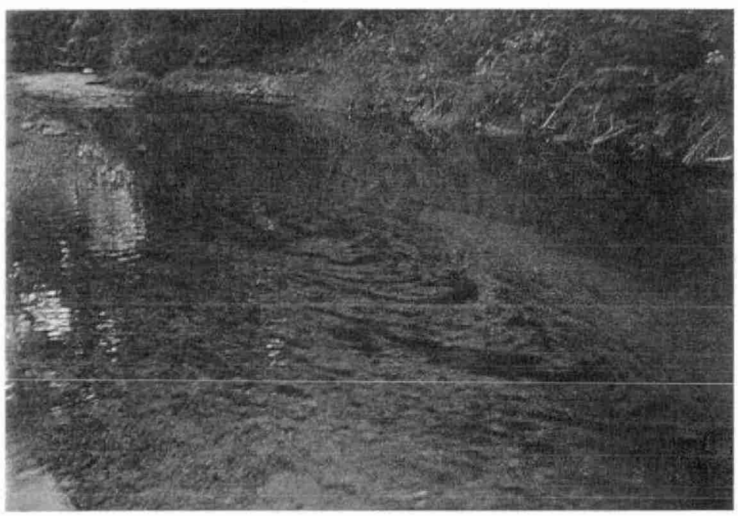

Figure 3: Pictures of the stream bottom at Site 1 (upper) and filamentous algae between sites 2 and 3 along Mill Creek.

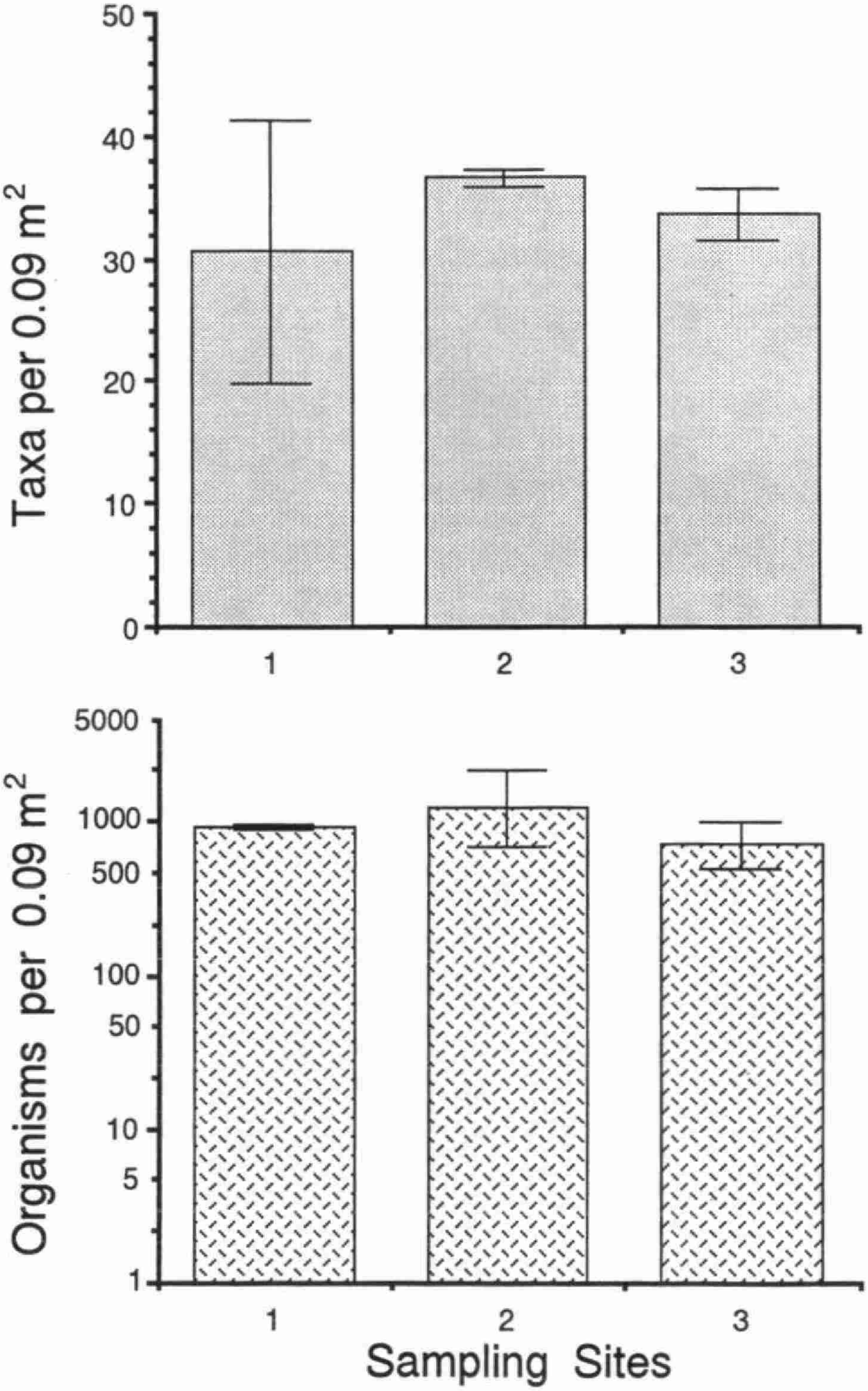

Figure 4: Species richness (upper graph) and macroinvertebrate density (lower graph) at 3 sampling sites along Mill Creek, August 1993. Error bars represent 1S.D. See Figure 1 for location of sampling sites.

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